



Creating Market Opportunities for Natural Gas Vehicles

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Today's Presentation

- Reasons for using NGVs
- The current U.S. market for NGVs
- Lessons Learned
- Clean Cities Partnerships



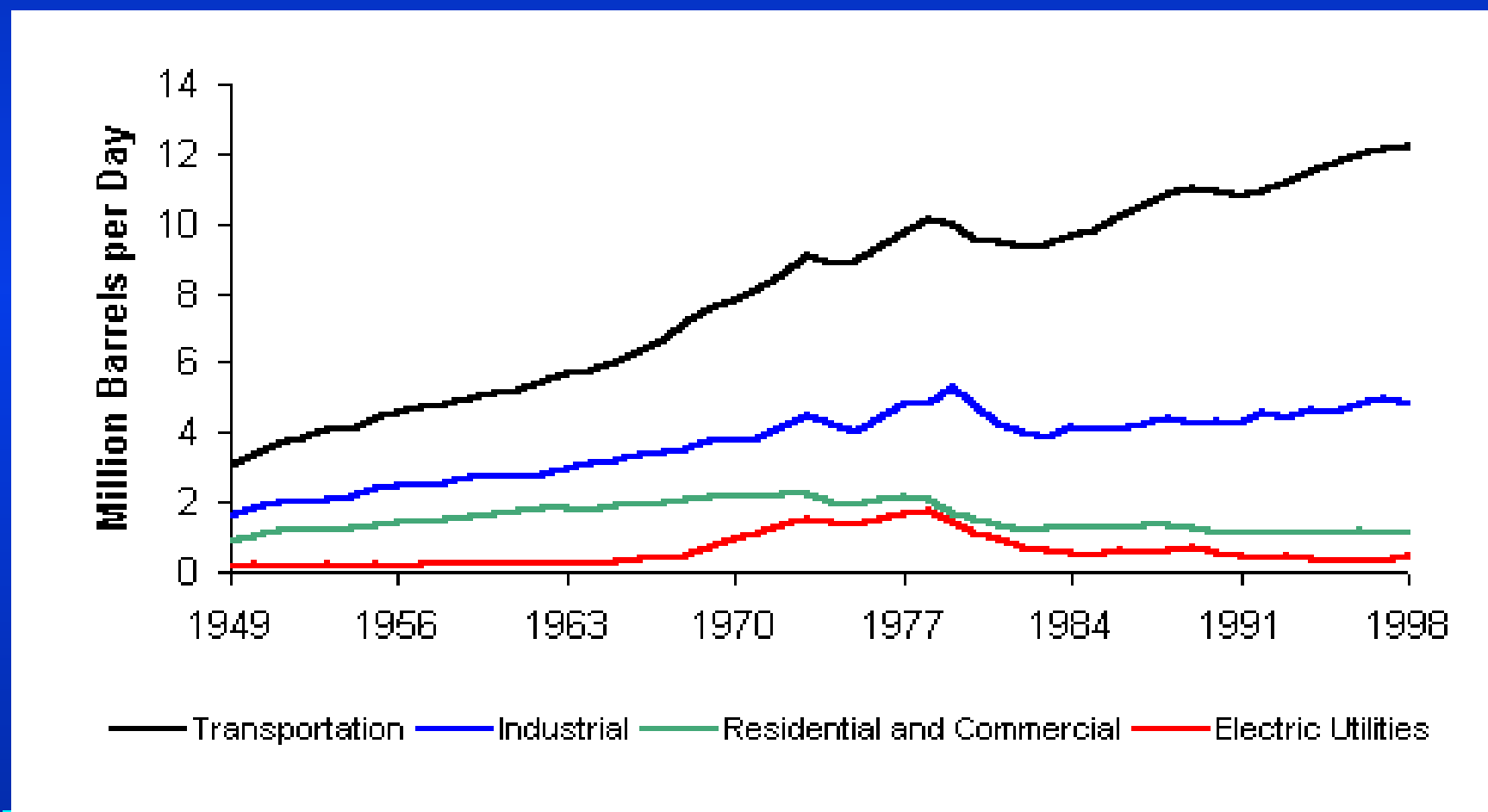


Why Alternative Fuels?

- National Security
 - 97% of transportation fuels are derived from petroleum
 - More than 53% of US oil is imported
 - Foreign oil demand will increase to 60% by 2005
- Trade Balance
 - U.S. pays \$50 - \$100 billion a year on oil imports
 - 1973 oil embargo resulted in 10% GNP loss
- Environmental Concerns

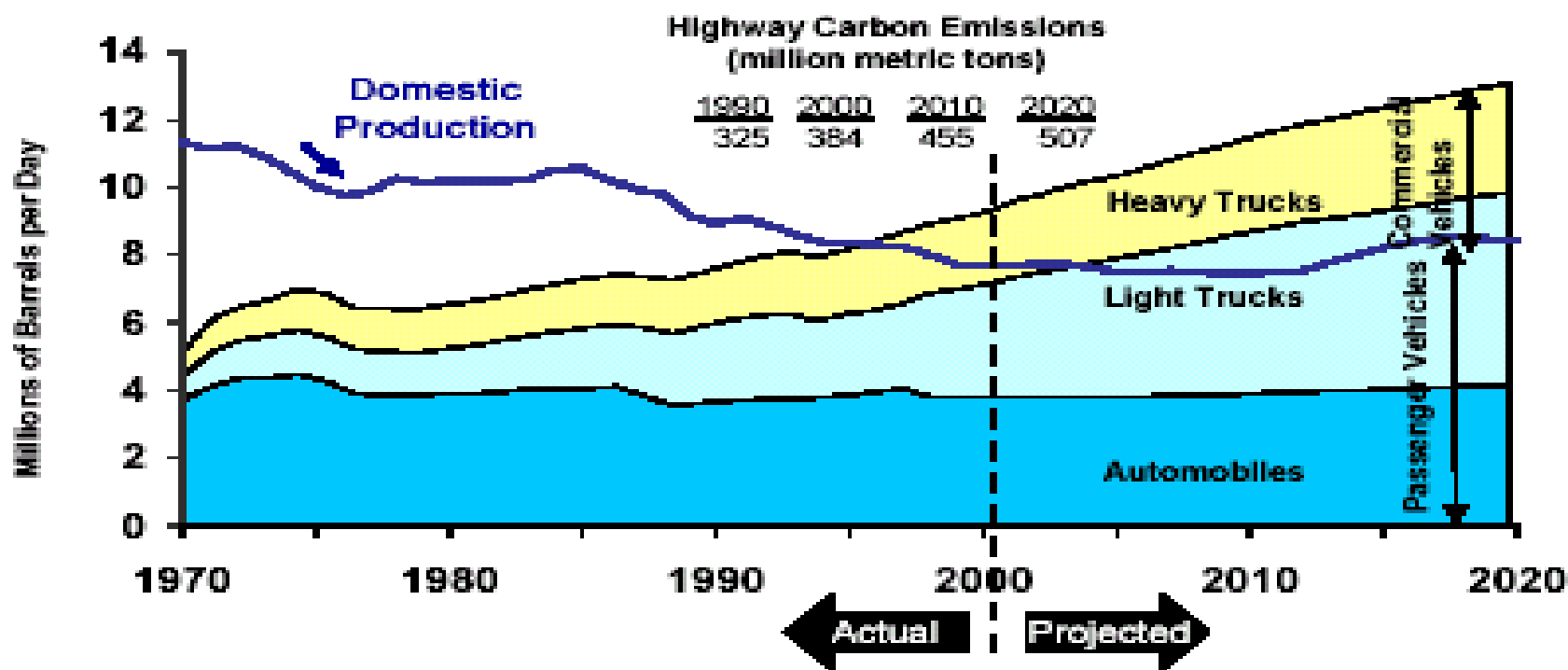


Transportation Fuel Use is Key



U.S. Transportation Demands More Oil

Source: Transportation Energy Data Book, Edition 21, DOE/ORNL-6068, September 2001, and EIA Annual Energy Outlook 2002, DOE/EIA-0383(2002), December 2001





Reasons for Encouraging Expanded Use of NGVs

- Energy security - reduces dependence on foreign oil
 - Large N. American resource of NG
 - Imports of LNG from abroad
 - Renewable opportunities - landfill gas
 - Long-term: methane hydrates
- National fuel availability
 - Stations: 1200+ vs. 95,000
 - Large established pipeline & distribution system

(continued)





Reasons for Encouraging Expanded Use of NGVs

- Air quality
 - Reduced ozone forming pollutants
 - Reduce particulates
 - Reduced air toxics
- Lower Operating cost
- Noise Reduction
- Export Opportunities





Current Status: Vehicles/Fuel Consumption

- ~110,000 NGVs on America's roads today (EIA)
- ~104 million gasoline gallon equivalents consumed (EIA)
- Most engine and vehicle choices of any alternative fuel





Current Status: Marketing Strategy



- Focus on high fuel use (primarily urban) fleets
 - More fuel use = faster payback
 - More fuel use = more emission reductions
 - More likely to be centrally fueled - less infrastructure needed
- Expand fueling infrastructure (currently 1200 plus) using
- Increased vehicle sales = mass production = economies of scale = reduced incremental price = increased sales
(current demand inadequate)





Breakdown of U.S. CNG Market

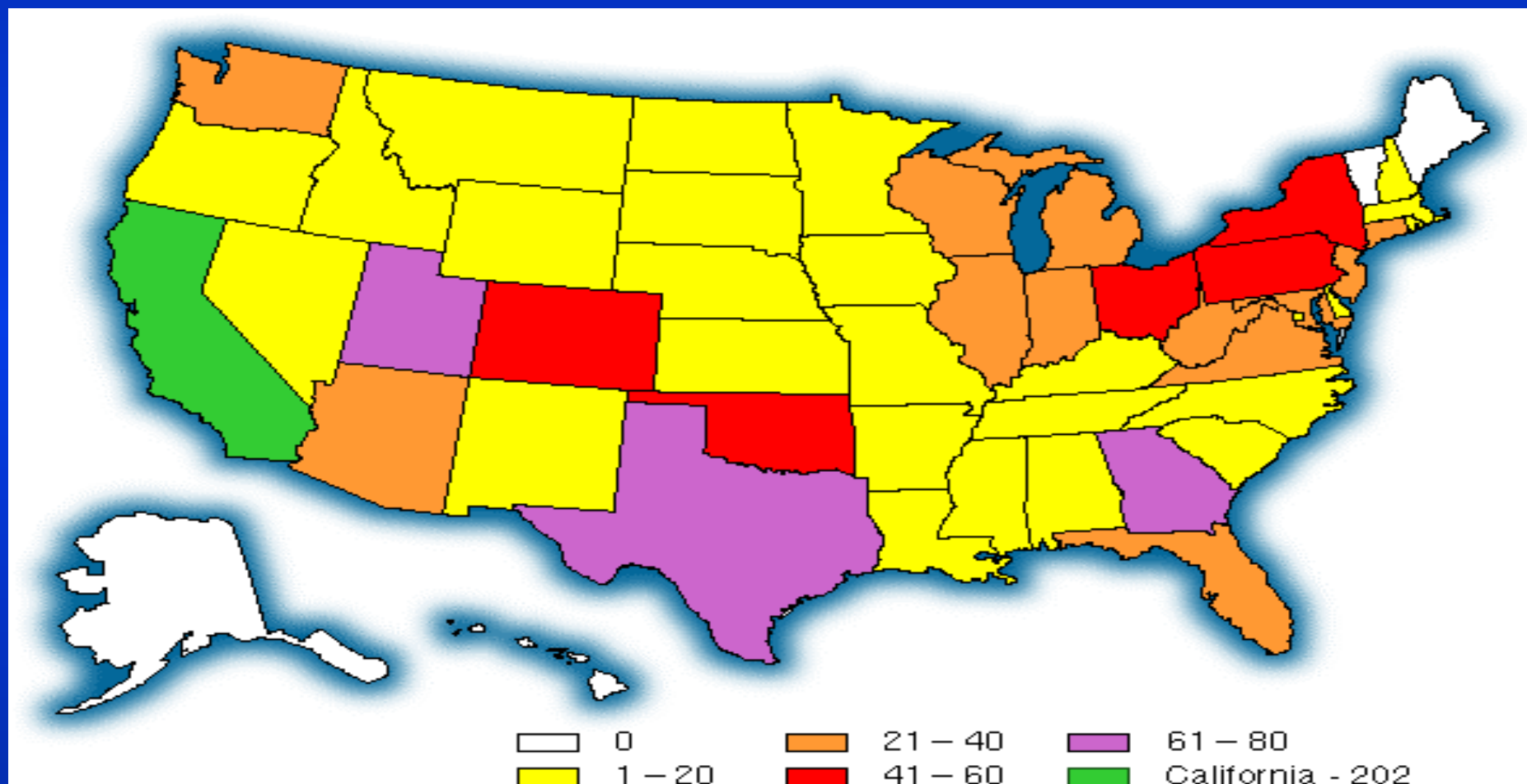
	In-Use Vehicles			Average	2001	Vehicle Fuel	Average Vehicle
				Annual Growth %	Percentage of	Consumption (gge)	Fuel Consumption (gge)
Fuel Type	1992	2000	2001	Rate 1992 - 2001	Total	2000	2000
CNG	23,191	101,991	109,730	41%		104,501,000	1025
LDV		82,384	88,728			40,416,000	491
HDV		19,607	21,002			64,085,000	3268
Private		57,796	57,481		52%	44,623,000	772
LDV		47,400	47,121				
HDV		10,396	10,360				
State		29,733	35,335		32%	54,865,000	1845
LDV		21,415	25,514				
HDV		8,318	9,821				
Federal		14,462	16,914		15%	5,013,000	347
LDV		13,569	16,093				
HDV		893	821				



Breakdown of U.S. LNG Market

	In-Use Vehicles		Average	2001	Vehicle Fuel	Average Vehicle
			Annual Growth %	Percentage of	Consumption (gge)	Fuel Consumption (gge)
Fuel Type	1992	2000	Rate 1992 - 2001	Total	2000	2000
LNG	90	1,682	2,039	241%	7,460,000	4435
LDV		118	221		65,000	551
HDV		1,564	1,818		7,395,000	4728
Private		355	472	23%	1,183,000	3332
LDV		75	117			
HDV		280	355			
State		1,187	1,514	74%	5,878,000	4952
LDV		43	60			
HDV		1,144	1,454			
Federal		140	53	3%	399,000	2850
LDV		-	44			
HDV		140	9			

U.S. Natural Gas Fueling Stations (CNG)



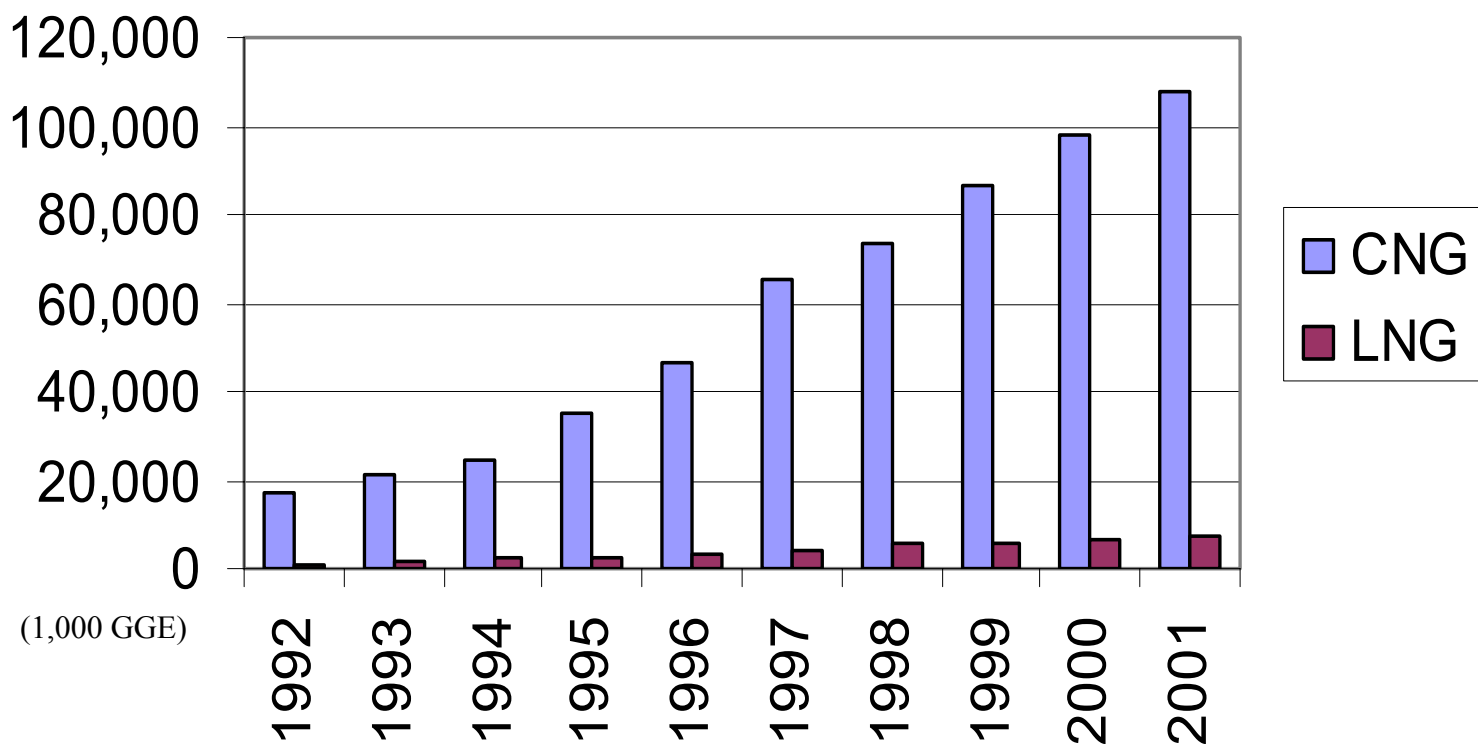


NG Transit Bus Figures

			Potential
2001	Existing	On-Order	Orders
All Buses	55,190	7,259	13,245
Alternative Fuel Buses*	5,131	1,856	2,935
Undecided			1,317
Natural Gas Buses			
CNG	4,058	1,632	2,385
CNG & E-Battery	16	45	
CNG & Diesel	48		
CNG & Gasoline	31		
LNG	575	117	465
LNG & Diesel	267		
LNG & E-Battery	3	18	
Natural Gas Bus Totals	4,998	1,812	2,850
NG%/AFVs	97%	98%	97%
NG%/Buses	9%	25%	24%



CNG & LNG Consumption





Importance of Transit Fuel Consumption

					Percentage of
Year	CNG DGE	LNG DGE	Total (DGE)	Total (GGE)	All NG Use
1992	1,009,000	191,000	1,200,000	1,331,023	8%
1993	1,579,000	474,000	2,053,000	2,277,158	10%
1994	4,835,000	1,450,000	6,285,000	6,971,231	26%
1995	10,740,000	2,236,000	12,976,000	14,392,790	38%
1996	15,092,000	2,862,000	17,954,000	19,914,315	40%
1997	23,906,000	4,030,000	27,936,000	30,986,205	45%
1998	37,268,000	5,331,000	42,599,000	47,250,191	60%
1999	44,398,000	7,672,000	52,070,000	57,755,286	63%

Natural Gas Buses





Light Duty OEM NGVs

Model Year 2002

- Ford
 - * Crown Victoria sedan (dedicated)
 - * Econoline vans (dedicated)
 - * F-series pickups (dedicated & bi-fuel)
 - * F- 450 Cutaway (dedicated)
- Honda
 - * Civic sedan (dedicated)
- Toyota
 - * Camry sedan (dedicated)
- GM
 - * GMC/Chevy 2500 pickup (bi-fuel)
 - * GMC/Chevy Vans (bi-fuel)
 - * Chevy Cavalier sedan (dedicated)
- Chrysler
 - * Mid-size van (dedicated)
 - * Maxi-van (dedicated)





Medium/Heavy-Duty Natural Gas Engines Available

- Caterpillar
3126; C-10; C-12
- Cummins
B5.9; C8.3
- Deere Power Systems
6.8L; 8.1L
- Detroit Diesel
50G; 60G
- Mack
E7G
- AFT (N466 Navistar
Re-power)
- Crusader/IMPCO
4.3L; 7.0L



Truck Manufacturers Offering Natural Gas Models

- Freightliner
- Peterbilt
- Mack
- Volvo GM
- Crane Carrier
- Athey
- Elgin
- Ottawa
- SISU





Bus Manufacturers Offering Natural Gas Models

- **Transit Buses**
 - Orion
 - NeoPlan
 - El Dorado
 - North American Bus
 - New Flyer
 - NOVA
 - TransTeq
- **School Buses**
 - Blue Bird
 - Thomas Built
- **Shuttles**
 - El Dorado
 - Blue Bird
 - Champion
 - Goshen
 - Metrotrans
 - North American
 - Transit
 - Orion



Future Growth Opportunities for NGVs





Government Fleet Rules

- Energy Policy Act
 - Federal (75% LDVs)
 - State (70% LDVs)
 - Fuel providers (90% LDVs)
- States moving to adopt fleet programs (CA, TX)





Government Economic Incentives

- CLEAR ACT (“Clean Efficient Automobiles Resulting from Advanced Car Technologies”) (proposed)
 - Expanding existing incentives
 - 50%-85% tax credit on incremental price of vehicles
 - 50 cent tax credit for each gge of natural gas used
- Green school bus legislation (\$300 million over 5 years) (proposed)
- Alternative Fuel Vehicle Acceleration Act (\$200 million) (connecting AFVs to existing transportation systems) (proposed)

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Hybrids Applications

- HD hybrids: Vehicles of the future in urban areas
 - In series hybrid, no idling and no heavy acceleration
 - Closes efficiency gap between diesel and otto cycle engines
 - Regenerative braking reduces weight-related energy penalty
 - NG hybrids cleaner than diesel hybrids
- Implication: NG engine more attractive in series hybrid (i.e., urban cycle) applications



Hydrogen Future

- Hydrogen is widely believed to be the ultimate transportation fuel
- NGVs are the pathway (maybe, the only pathway) to hydrogen transportation future
- Expanded use of today's NGVs could accelerate introduction of hydrogen vehicles





NG: Pathway to Hydrogen Economy

- Hydrogen for fuel cells:
 - currently almost all commercial applications rely on natural gas as the source for hydrogen
- Long-term future:
 - Hydrogen from cheap (possibly, solar) electricity
- Until then, natural gas will be the main hydrogen source
- Reforming natural gas into hydrogen more environmentally friendly than reforming petroleum fuels
- Relying on petroleum for hydrogen does not adequately address energy security concerns

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Pathway to Hydrogen Economy

- A national hydrogen transportation system needs:
 - Local hydrogen production
 - High pressure or cryogenic gas storage
 - Gas or cryogenic liquid metering and dispensing
 - Garage and maintenance facilities equipped to handle gaseous fuel vehicles
 - Mechanics, inspectors, etc. trained to work with gaseous fuel vehicles
 - Customers that are comfortable with gaseous fuel vehicles





Challenges Facing NGV Industry

- Reduced role of utility industry
- Indifference of producers
- Petroleum fuels & vehicles becoming more environmentally friendly
- Private & public RD&D efforts heavily favor petroleum vehicles





Lessons Learned

- Importance of Incentives - 1992 GAO Report on Alternative Fuels
 - Government action and leadership was critical to increasing AFV use
 - "A favorable price for the fuels relative to gasoline strongly influenced the ability to interest private motorists and fleet operators in using alternative fuels."
- European study on low-sulfur fuel incentive report
 - need consistent and dedicated incentives
- Current U.S. regulatory requirements are helpful but not sufficient to create sufficient demand to overcome market hurdles





Lessons Learned

- Shaping public policy is key step in developing markets for NGVs
- Companies need to work with environmental community and other alternative fuel representatives to capitalize on benefits of alternative fuels and advocate incentives
- States with strong incentive programs have strong NGV programs





Lessons Learned

- Safety is critical
 - Need to establish proper safety procedures
 - Develop standards for equipment
 - Public acceptance
 - Local government acceptance
 - Educate community on safety aspects of NG
- Training
 - Mechanics, technicians, and drivers
- Leadership
 - Management support critical
- Emission Standards
 - Emissions performance specifications





Natural Gas in Transit Fleets Summary

- Access to an adequate fueling site is crucial
 - ◆ Over half of challenge fleets do not have fueling site or have had difficulties with fueling
- Training of maintenance personnel must be thorough
 - ◆ 36% of fleets listed training as most critical for success
 - ◆ Successful fleets refer to an adjustment period or “learning curve”
- Successful fleets have a high level of commitment
- There appears to be an economy of scale
 - ◆ Of the 10 fleets with 10 or less total NG buses, 8 fall in the overall challenge group.
 - ◆ 6 out of those 8 mention lack of training and knowledge of the NG buses is a problem





Document	Applicability	Comments
Design Guidelines for Bus Transit Systems Using Compressed Natural Gas as an Alternative Fuel (6/96)	Transit Facilities but useful reference for other fleets	FTA Report - Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.
Compressed Natural Gas Safety in Transit Operations (10/95)	Transit Facilities but useful reference for other fleets	same as above
Liquefied Natural Gas Safety in Transit Operations (3/96)	Transit Facilities but useful reference for other fleets	same as above
Uniform Fire Code - 1997	"The most widely adopted model building code in the US"	May be the fire code used in your area. Check with local fire marshal
International Fire Code - 2000	"New" fire code	Check with local fire marshal on applicability
CSA B108-99 Natural Gas Fuelling Stations Installation Code	Canadian Std. applicable to fleet and public stations	
CSA B108-99 Annex – Indoor Refuelling of Natural Gas Vehicles	Canadian Std. Fueling facilities within a building that has primary functions other than fueling. Does not cover public stations.	Proposed Annex nearing publication
CSA B109-01 – Natural Gas for Vehicles Installation Code	Canadian Std. Applies to "installation, servicing and repair of NG fuel systems on self-propelled vehicles."	
ANSI NGV1-1994 (with 1997 and 1998 addenda) – Compressed Natural Gas Vehicle Fueling Connection Devices	CNG vehicular fueling connection devices	Assures standardized nozzles and receptacles
ANSI NGV2-2000 – Basic Requirements for Compressed Natural Gas Vehicle Fuel Containers	CNG fuel containers	Container requirements in addition to FMVSS 304.
ANSI NGV3.1-1995 – Fuel System Components for Natural Gas Powered Vehicles	Fuel system components for NGVs (excludes LNG components upstream of vaporizer)	Primarily for converted vehicles.
ANSI NGV4.1-1999 – NGV Dispensing Systems	CNG vehicular fuel dispensing systems	
ANSI NGV4.2-1999 – Hoses for NGVs and Dispensing Systems	CNG dispenser and vehicular hose assemblies	
ANSI NGV4.4-1999 – Breakaway Devices for Natural Gas Dispensing Hoses and Systems	CNG dispenser shear valves and fueling hose emergency breakaway shutoff devices	



Standards/Document	Applicability	Comments
NFPA 52 – Compressed Natural Gas Vehicular Fuel Systems Code – 1998	CNG vehicles (incl. marine) and fueling facilities,	Probably single best source of guidance for CNG vehicles and fueling facilities.
NFPA 57 – Liquefied Natural Gas Vehicular Fuel System Code - 1999	LNG and LNG to CNG vehicles (incl. marine) and fueling facilities	
NFPA 88B – Standard for Repair Garages - 1997	All garages used for major repair and maintenance of motorized vehicles	Has some specific requirements for garages working with NGVs, such as ventilation, electrical requirements near the ceiling, temperature of exposed surfaces on heaters.
NFPA 88A – Standard for Parking Structures – 1998	Open, enclosed, basement and underground parking structures	No special requirements for NGVs other than reference to NFPA 52 and 57
NFPA 30A – Code for Motor Fuel Dispensing Facilities and Repair Garages - 2000	Applies to facilities dispensing both gaseous and liquid fuels at the same facility	Includes requirements of 88B.
NFPA 59A – Standard for the Production, Storage, and Handling of Liquefied Natural Gas - 1996	Site selection, design, construction, and fire protection for LNG facilities.	
SAE J1616 – Recommended Practice for Compressed Natural Gas Vehicle Fuel	CNG	Recommendations on vehicular fuel composition.
SAE J2323 – Recommended Practices for LNG Powered Heavy Duty Trucks	LNG	Primarily heavy truck recommendations but some maintenance facility equipment and procedures.
Design Guidelines for Bus Transit Systems Using Liquefied Natural Gas (LNG) as an Alternative Fuel (3/97)	Transit Facilities but useful reference for other fleets	FTA Report - Not only references required codes (e.g., NFPA) but also suggests additional precautions and provides general information.



Document	Applicability	Comments
ANSI NGV4.6—1999 – Manually Operated Valves for Natural Gas Dispensing Systems	Manually operated CNG valves, excluding cylinder shut-off valves	
ANSI PRD1-1998 (with 1999 addendum) – Basic Requirements for Pressure Relief Devices for Natural Gas Vehicle Fuel Containers	Pressure Relief Devices for CNG Fuel Containers	
CGA C-6.4-1998 – Methods for External Visual Inspection of Natural Gas Vehicle Fuel Containers and Their Installations	CNG vehicular fuel containers	Referenced in ANSI NGV2
49 CFR 571.304, FMVSS 304 – Compressed Natural Gas Fuel Container Integrity	CNG motor vehicle fuel containers	DOT Federal Motor Vehicle Safety Standard for CNG motor vehicles.
49 CFR 571.303, FMVSS 303 – Fuel System Integrity of Compressed Natural Gas Vehicles	CNG vehicles $\leq 10,000$ lbs. GVWR and school buses	DOT Federal Motor Vehicle Safety Standard for crash test of light duty vehicle and school bus CNG fuel systems.
49 CFR 393.65, FMCSR – All Fuel Systems	Commercial vehicles in interstate commerce	DOT Federal Motor Carrier Safety Regulations
CA Code of Regulations, Title 13, Div 2, Ch 4, Article 2	Fuel systems using LNG in 15 CCR 935, CNG in 13 CCR 934	CA requirements
TX Administrative Code, Title 16, Part 1, Ch 13	CNG regulations in Subchapter E, LNG regulations in Subchapter M	TX requirements





Contact Information

Organizations/U.S. Agencies	Phone	Internet
National Fire Protection Association (NFPA)	1-800-344-3555	http://catalog.nfpa.org
Society of Automotive Engineers (SAE)	774-726-0790	www.sae.org/products
Federal Transit Administration (FTA)	William Hathaway 617-494-2081	www.fta.doe.gov
	National Technical Information Service 703-605-6050	www.ntis.gov
Uniform Fire Code	Uniform Fire Code Association at 760-723-6911	www.wfca.com/ufca
International Fire Code	International Codes Council 703-931-4533	www.intlcode.org
Canadian Standards Association (CSA) a	1-800-463-6727	www.csa.c
ANSI Standards/NGVs	202-824-7361	kbatte@ngvc.org
Compressed Gas Association (CGA)	703-788-2700	www.cganet.com
U.S. Code of Federal Regulations		www.access.gop.gov (see CFR, Title 49)
California Code of Regulations (CCR)		http://ccr.oal.ca.gov
Texas Administrative Code		http://info.sos.state.tx.us:80/pub/plsql/readtac\$ext.ViewTAC



Clean Cities

- A voluntary, locally based government/ industry partnership
- Currently 77 Active Cities
- Over 4,400 Stakeholders
- 96 million gallons of petroleum displaced per year
- 19,000 metric tons of emissions reduced per year





Educating Fleets

- Toll-free hotline 1-800-CCITIES
- Conferences and workshops
- Case Studies
- Website
- Searchable online database





Local Clean Cities Objectives

- Identify and Educate Fleets About Alternative Fuels
- Build Necessary Refueling Sites
- Train Drivers, Mechanics and Others
- Educate the Public
- Find Adequate Resources for AFV Projects
- Encourage Governments to Pass Legislation Favorable to AFVs



Niche Markets Have Much Potential





Niche Market Vehicles are Large Fuel Consumers

Vehicle	Total Population of Vehicles in U.S.	Fuel Use per Year for Total Population (million gal)
Transit Buses	50,000	500
School Buses	500,000	824
Average HDVs	3,927,700	17,260
UPS Medium Trucks	57,000	57
Private Fleet Light Trucks	2,330,000	1,255
FFVs using E85	750,000	404
Total Vehicles	7,614,700	20,300





Clean Cities International

- Clean Cities International facilitates international exchange and government/industry partnerships to promote alternative fuel technologies in order to address shared energy and environmental issues.
- New Clean Cities International Web site: www.ccities.doe.gov/international





What Assistance is Clean Cities International Providing New Delhi?

- Clean Cities Model/Assistance to Establish Coalition
- Train the Trainer Program for CNG/LPG
- Use of Clean Cities Public Outreach/Technical Materials
- Reverse Technology Tour to the U.S.

